Bradford, (H. W.)

THE ELECTRO-MAGNET

IN

OPHTHALMOLOGY,

WITH A DESCRIPTION OF A NEW MAGNET.

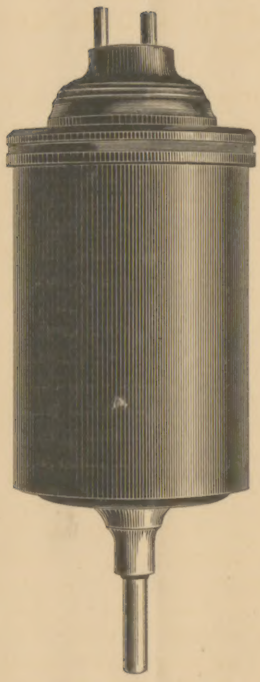
BY

HENRY W. BRADFORD, M. D.,

ASSISTANT AT THE MASSACHUSETTS CHARITABLE EYE AND EAR INFIRMARY.

[*Reprinted from the Boston Medical and Surgical Journal of March 31, 1881.*]

CAMBRIDGE:
Printed at the Riverside Press.
1881.



ELECTRO-MAGNET
(Full size cut).
Suspensive force, twenty ounces

THE ELECTRO-MAGNET IN OPHTHALMOLOGY, WITH A DESCRIPTION OF A NEW MAGNET.

BY HENRY W. BRADFORD, M. D.,
Assistant at the Massachusetts Charitable Eye and Ear Infirmary.

THE rapidly extending use of the electro-magnet for the purpose of removing fragments of iron and steel from the interior of the eye, the slight attention previously bestowed on this method of procedure, and the imperfect knowledge of the subject displayed in many of the published articles, have induced me to bring forward the following views. They are the result of several years' practical study. And their main object is to demonstrate that in the application of a properly constructed magnet we possess an efficient means of treating cases for which enucleation has hitherto been practically considered the sole resort.

Magnetism may be applied to the eye from either a permanent or an intermittent source, that is, either from a so-called permanent magnet, which, once excited, retains its magnetic power indefinitely, or from a magnet which becomes such only when excited by the electric current. And the superiority of the latter is incontestible. It exceeds its rival by many times in power, when of less weight and smaller size. The permanent magnet is, moreover, open to the objection of being liable to a constant dissipation of its energy upon receiving any sudden shock or blow, upon moving across the magnetic meridian of the earth, and even when at rest, unless guarded by an armature whose weight nearly equals its suspensive power.

The electro-magnet must then be the one employed for the purposes of ophthalmic surgery. And in mod-

eling such an instrument for use about the eye, it is evident that we must combine the minimum of size with the maximum of power. To this may be added, for the sake of convenience, with the smallest and most compact battery that proves itself available.

It is in precisely this three requisites that previous electro-magnets have been deficient. When small their power has been insufficient. When large they have been clumsy, have supplied little power in proportion to their size, and have required a large number of cells to develop their full force.

Having, in the course of the experimental study of this subject, constructed some fifty magnets, of every variety of shape and size, I would advance the following magnet, as giving the best results accomplished: —

The core is composed of soft Norway iron, one third of an inch in diameter, and two and one half inches in length; to one end of this solid cylinder is riveted a flat circular disc of the same material, one inch in diameter, and one sixteenth inch thick.

The surrounding helix is composed of insulated copper wires, weighing twenty-nine grains to the foot, making eight convolutions of one and three quarters inch in length.

The polar extensions are respectively five, four, and three thirty-seconds of an inch in diameter, and one half inch in length; their suspensive power equals twenty, sixteen, and eleven ounces each, when an armature of soft iron, one inch by one tenth in diameter is used, which is within two ounces of the saturation point.

The battery used is a single bichromate of potash cell, having eight square inches of negative surface. The magnet weighs about five ounces, and the intensity of its field by the addition of another cell is made as great as that of a magnet capable of lifting a ton.

The use of large magnets capable of lifting enormous weights offers no advantage over the one above described, as their field is no more intense, and, unless

the foreign body is of many pounds weight, does not exert any greater force. It may be laid down as a law that the *size* of the magnet should be in proportion to the size of the body acted upon: if a large body of iron is to be suspended, then a large battery power and correspondingly large magnet must be used; but should the foreign body be of small size, such as would be met with in the eye, a small single cell magnet magnetized to saturation will give the same amount of suspensive force, as the magnetic field of each will be the same in intensity, differing only in size.

In regard to the quality of material nothing but the most soft and pure iron should be used; the use of impure commercial iron is open to the objection that its saturation point is much lower than that of the brand known as Norway iron, and as it retains its magnetism, upon making attachment to the battery a second time this may have to be overcome, thereby raising the temperature and lowering the magnetism; this takes place, if the poles of the magnet are reversed, by connecting the battery in a different manner than at the first.

Having finished the construction of the electro-magnet we will pass over to its application and use in ophthalmology.

Foreign bodies that enter the eye may lodge in any one of the following structures, and, commencing with the most superficial, the cornea, they might pass through the anterior chamber, the iris, lens, vitreous, and choroid. Of the metallic substances which enter the eye none are removable with the magnet except pieces of iron and steel. Those that enter and lodge in the cornea may be divided into two classes: first, those minute fragments which enter its surface and are removed by means of the needle, and over which a magnet has no practical effect because of their small size; and, second, those which have an appreciable size. These latter may be extracted in the following manner: The point of the above-constructed magnet is brought in direct contact with the foreign body, and

then moved away to the distance of a fourth of an inch; this manœuvre is repeated several times, and if the case is seen before the corneal wound has had a chance to heal, the foreign body will finally be found adhering to the point of the instrument. If, however, the wound has healed a change in the procedure is necessary. While keeping the magnet in close proximity to the foreign body, an incision through the wound is to be made for the purpose of allowing a free exit, the manœuvre of touching and withdrawing the instrument must be gone through with again and again, and ultimately the foreign body will be easily removed. These two methods are entirely sufficient for the extraction of all fragments in this tissue, as long as any part of them is in the cornea, even though the greater portion of their bulk projects into the anterior chamber.

The anterior chamber may be the resting-place of a fragment, and if so, it should be drawn to the margin of the cornea, and extracted through an incision in that region either by the forceps or magnet, at the option of the operator, who should bear in mind the importance of keeping the magnet in close proximity to the metal to be extracted if forceps are used, in order that the fragments may not be lost by means of the forceps slipping.

Fragments situated in the iris may be extracted by two different methods by the use of the attractive or suspensive force; in the first method the magnet does not enter the eye at all, but exerts its influence from the outside in the following manner: The eye is seized with a pair of fixation forceps, an assistant keeps the point of the magnet directly over the fragment imbedded in the iris, the operator, with a stop needle, enters at the margin of the cornea nearest the fragment, in a horizontal plane, and with the extremity of the needle loosens the fragment from its point of attachment, the magnet then seizes and withdraws it to the edge of the cornea, where an incision is made for

its removal. The second method, which is by far the simplest, is to make an incision nearly at the edge of the cornea, and pass the point of the magnet directly inwards until contact is made, and upon withdrawal the fragment will be found attached to the polar extension; the certainty of this fact is assured, as this magnet is able to draw through normal iris tissue a fragment of iron the size of a pin head.

Fragments imbedded in the lens may, if a traumatic cataract has formed, be removed by either of the above stated methods. If, however, a foreign body is found resting against the anterior capsule and external to it, the magnet alone must of course be used to effect its removal, an incision through the margin of the cornea being practiced for that purpose.

Fragments in the vitreous may be classified under two heads: those that are fixed in position, and those that are free; in the former case no attempt at removal by means of the attractive force of the magnet will be successful, except by bringing the point of the instrument in the closest proximity to the foreign body when we no longer use this power, but its associate, the suspensive force. In other words, contact with the body should be made with the magnet in order to overcome any adhesions that may exist. This, however, does not apply when the fragment exists in the vitreous, unattached to any surrounding tissue, for then the attractive force of the magnet will draw the body to the choroid at the nearest point, from which position it can be removed through an incision; this action, however, is not an instantaneous one, for the time needed in the manœuvre will vary according to the consistency of the vitreous and size of the foreign body; should the fragment be fixed in the substance of the choroid and sclera the eye should be rotated in the necessary direction until the site of impactment is brought into view, and in order to accomplish this some division of muscle may be necessary in order that sufficient rotation may be accomplished. An incision

is then made as close as possible to the imbedded body, and the magnet, which, during this time, is held in position to keep the fragment from being dislocated, should be passed straight into the eye, avoiding all lateral movements; upon withdrawal the fragment should be found adhering.

Having stated the method of treatment for fragments which may lodge in any of the different tissues of the eye, a few remarks in regard to the general facts of the employment and use of the magnet may be introduced. The amount of suspensive power of any magnet, when saturated, as every magnet used in ophthalmic surgery should be, depends upon the size of the foreign body. Hence, the larger the fragment the more probable its removal, and, conversely, the smaller the fragment the more difficult its extraction. Finally, a point may be reached where the resistance to be overcome exceeds the amount of polarity capable of being induced. This is illustrated in the case of minute foreign bodies in the cornea, where the magnet is of no avail. All incisions for removal of foreign bodies anterior to the plane of the lens should be marginal incisions of the cornea, those that concern the vitreous should be scleral, and made posterior to the ciliary border; in both cases, by so doing, the ciliary body is avoided, and in the latter case the surrounding tissues form the best support for the wound.

One important point in regard to all incisions made for the entrance of the magnet, and the removal of a foreign body from the eye, is *that the cut should be not one with parallel edges, but T-shaped*, as in the former case, when the extraction of the foreign body takes place, it is invariably stripped off the end of the magnet, and is retained at the site of the wound, or drops into the interior of the eye. This is a foregone conclusion unless the lips of the wound be held apart, and no amount of skill or carefulness upon the part of the operator can guard against it, unless the incision is of the above-mentioned shape.

Every magnet having a north and south pole, the supposition would be that they would have the same amount of suspensive force; this, however, is not so, and the explanation of this fact must be sought for in the laws of tension of the electrical current. Should we wish to gain the maximum of attractive force the magnet must be constructed with a diameter proportioned to its length as one to twenty-four or more, this, of course, requiring more battery power.

The following cases of removal of fragments of iron and steel from the eye have occurred in the clinic at the Massachusetts Eye and Ear Infirmary. This electro-magnet or modifications of it have been used, and the gradual decrease in size and the increase in suspensive force of the instrument are worthy of notice.

CASE I. November 18, 1879. F. S., machinist, aged twenty-four, received a blow upon the eye while at work chipping steel; piece penetrated cornea, and lodged in the substances of and posterior to the iris, with an exposure of only a point of one of its extremities upon it. The lens was opaque. Iridectomy was attempted, but unsuccessfully, hæmorrhage ensuing, the fragment disappeared, and could neither be seen or felt; the point of the electro-magnet was then passed into the eye at the place where the foreign body had been situated, and after the second trial it was seen engaged in the wound and removed with forceps. The magnet used weighed seventeen ounces, and had a suspensive force equal to eight ounces. Dr. F. P. Sprague, in whose clinic the case occurred, soon after removed the cataract, and when last seen, August 16, 1880, the patient had vision of six eighteenths.

Details of the second and third cases occurring in the services of Dr. B. Joy Jeffries, and Dr. C. H. Williams, may be found in the December 30, 1880, number of the Boston Medical and Surgical Journal. The magnet in each of these cases weighed eight ounces, and the ratio of suspensive force had increased to sixteen.

In the fourth case, that of J. S., stone cutter, aged twenty seven, who came to Dr. Henry L. Shaw, the foreign body, a thin scale of steel, had passed through the cornea, and projected nearly two thirds its diameter into the anterior chamber. As the corneal wound had partially healed over the fragment, all attempts towards its removal were unsuccessful until the wound was reopened with the knife, when the fragment was immediately grasped by the magnet and withdrawn. The weight of the instrument, whose construction was the same as previously described, was five ounces, and its suspensive ratio had increased to over twenty.

The point of the magnet, shown in the engraving, can be removed, and smaller ones attached. Several of these accompany the instrument, which may be obtained of the manufacturer, Thomas Hall, 19 Bromfield Street, Boston.